Threats to the Ecological Character of the Mývatn-Laxá Ramsar Site Due to the Bjarnarflag Geothermal Power Plant Project

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Introduction

The Lake Mývatn-River Laxá ecosystem was designated as a Ramsar site in 1977, the first site in Iceland to be listed[1]. The site was added to the Montreux Record in 1990 and removed from it in 1993. One of the main threats to the ecosystem has been strip diatomite mining from the bottom of the lake. Mining was operated between 1967 and 2004. Research has confirmed some negative impacts on the ecosystem, including: a) changes in conditions for bottom vegetation resulting in a decline of *Potamogeton filiformis*, a plant species important to waterfowl grazing[2]; b) increased nutrient concentrations, in particular nitrogen and phosphorus, as these got released from the dredged sediment and flushed with run-off water from the mining plant into the groundwater and subsequently into the lake[3]; c) accumulation of newly formed sediment (detritus) into dredging holes in the lake, making it no longer available to organisms depending on it as food source. As a fundamental link in the food webs of the lake, lack of detritus caused natural biological fluctuations to increase[4]; d) as a consequence of periodic food shortage and increased vulnerability to fishing mortality it is very likely that the arctic charr population (*Salvelinus alpinus*) collapsed. Fish catch has declined severely from about 32,000 individuals (mean weight 2kg) to less than 2,000 individuals per year (mean weight 0.5kg)[5].

The recovery of the Mývatn-Laxá ecosystem is of high priority. In the 2011-2016 Management Plan for the area, strong emphasis is put on decreasing any stress factor to the system[6]. This may be regarded as vital to the conservation of the area. It is therefore of immense concern that the National Power Company of Iceland (NPC) intends to build a two phase 90MW geothermal power plant in Bjarnarflag geothermal area, starting later this year. The plant will be located in only about 3km vicinity of the lake. Environmental problems relate to pollution from plant operations, including waste water run-off, changes in temperature of groundwater inflow into the lake, and airborne hydrogen sulfide.

Current geothermal energy production on Lake Mývatn´s catchment area

In Bjarnarflag, a 3MW geothermal power plant has been operated since 1969 and in Krafla, another 60MW plant was established in the late seventies. Krafla is also located on Lake Mývatn´s catchment area, but 9km from the lake. For both these plants waste water has been dumped onto the land surface, creating surface reservoirs from which waste water flows rapidly into the groundwater. Groundwater from both areas flows down to Lake Mývatn[7][8][9]. In Krafla, part of the waste water has in recent years been pumped into underground compartments.

Although this paper primarily discusses the Bjarnarflag project, here concern is also raised about possible adverse impacts on the ecological character of the Mývatn-Laxá area due to the current Krafla power plant and potential future enlargement of it. The Icelandic National Power Company has announced their intention of building up to a 135MW power plant in the Krafla area, called Krafla II, and to enlarge the current plant by 40MW, in total an increase of 175MW[10]. The Icelandic government has prepared a parliamentary motion concerning a Master Plan for the Conservation and Energy Utilization of Geographical Areas in Iceland, building on a more than a 10 year long evaluation process. Both the Bjarnarflag project and the Krafla II project are listed in the utilization category in the parliamentary motion. Impacts of both of these plans combined on the Mývatn-Laxá area have not been evaluated.

Potential threats to the Mývatn-Laxá ecosystem related to the Bjarnarflag Geothermal Plant

The construction of the Bjarnarflag geothermal power plant is proposed to be divided into two 45MW phases, the first one starting later this year and scheduled to be completed in 2015. A final decision on the second phase has not been taken, but an environmental impact assessment was completed for the whole 90MW project in 2003.

Waste water run-off

The waste water from the current Bjarnarflag geothermal power plants is considerably more acid than the groundwater entering Lake Mývatn. Various substances are as well found in higher concentration, including silica, sulfate, iron, aluminum and arsenic. Some of these substances are poisonous to the lake´s biota and others could impact the chemical content in ways that may be poorly understood. An increase in waste water run-off from 50kg/s up to 180kg/s[11], raises a concern of potential pollution to the lake. It is known that underground currents carry groundwater from the Bjarnarflag area down to Lake Mývatn (see above). However, studies using chemical tracers have shown contradicting results. One study[12] showed at least one hundred million times thinning of iodide over a 2km stretch from the Bjarnarflag surface reservoir to Grjótagjá (a famous traditional bathing fissure close to Mývatn). A previous study[13] had indicated less thinning, but in the EIA report it was deemed unreliable due to pollution of samples, without a satisfactory explanation, and only the former used. That might, however, not fully explain certain high concentrations of iodides observed at several sampling locations in Lake Mývatn´s springs in the previous study. Also, local people have observed polluted (colored) water in Grjótagjá. It is only fair to request that these studies be repeated to learn more about groundwater flow in the area and possible concentrations of waste water run-off entering the lake.

In a 2011 review of the municipality´s local plan in the area[14], the Environment Agency (EA) claimed that it would be necessary to dump all waste water back down into the underground geothermal reservoir in order to decrease the potential impact on the surrounding environment. In light of increased problems with waste water in other geothermal plants in Iceland (the Hellisheidi and Svartsengi geothermal plants), the EA requested that in the case of the Bjarnarflag surface reservoir getting blocked, the potential environmental impacts of the waste water needed to be examined,

and a clearer picture to be drawn up of the proposed sites for pumping waste water into the underground geothermal reservoir.

In a meeting with local stakeholders in the Mývatn area in July 2012, the NPC announced their plans of pumping all waste water into lined 200-500m deep compartments in the ground, and underneath the groundwater currents that flow to Lake Mývatn. This is in accordance to the wishes of the Environment Agency. However, one consequence of this is the cooling of the natural groundwater flow, which is a fundamental factor in the special ecology of Lake Mývatn.[15] Most of the lake's silica, sustaining the rich growth of diatoms, is carried to the lake by geothermal water originating in the Bjarnarflag area. Silica concentration is positively correlated with temperature. Cooling can therefore result in precipitation of silica, altering the groundwater concentration of the element. It is very difficult to predict the ecological consequences of changes in silica concentrations in the lake. When asked during the meeting how much cooling the NPC expected, no clear answer was given, but it was noted that if cooling would be detected, the groundwater could simply be heated up by dumping waste water onto the surface.

The above raises a twofold concern. First, how secure is the underground pumping and what plans does the NPC have to respond to possible failures of pumping or storing of the waste water? Second, how much cooling of the natural groundwater is expected to occur, and which plans are in place to remedy such cooling?

Airborne pollution

Hydrogen sulfide (H_2S) and carbon dioxide (CO_2) are the main airborne pollutants associated with geothermal power plants. The latter is a known greenhouse gas. In addition to this, under certain conditions part of the H_2S can oxidize into sulfur dioxide (SO_2), which can cause acid rain if further oxidized in the atmosphere. This is, however, not expected to become a problem in the case of Bjarnarflag[16].

Health impacts of high concentrations of hydrogen sulfide exposure are fairly well known, and can be lethal to humans. Low and medium level exposure is much more poorly understood. The limited information available has shown that there are indeed chronic health effects from H_2S exposure. Studies indicate that individuals living in an area with increased H_2S concentrations are more likely to suffer from cardiovascular-, respiratory- or neurological morbidity[1718]. In Iceland, research in this field is seriously lacking. One study has shown that ambient H_2S levels are weakly associated with increased dispensing of drugs for obstructive pulmonary disease (anti-asthma drugs) in Iceland´s capital area[19]. Another study did not show any significant relation between ambient H_2S levels and the dispensation of drugs for angina pectoris[20]. In addition to this, some studies have been carried out on vegetation, reporting on moss damage in geothermal power plant areas related to hydrogen sulfide pollution[21], although a direct causal link could not be established since damaging concentrations of H_2S levels for moss are not known. Overall, although not conclusive, there is some evidence of negative effects of H_2S both on human health and moss in Iceland.

Hydrogen sulfide concentrations will greatly increase following construction of the Bjarnarflag plant[22]. This is of great concern to the inhabitants of the area and tourism as a whole. In the 2011 local plan review, the Environment Agency criticizes that in Reykjahlíd (the closest neighboring town),

the mean concentration of hydrogen sulfide is likely to exceed the human health limits 55 days a year (50 μg/m^3). According to a 2010 national regulation on concentration of ambient hydrogen sulfide, H_2S can exceed this limit five times a year until 2014, but after that zero times[23]. This limit is somewhat lower than the 150 μg/m^3 limit recomended by the World Health Organization. When asked about this during the aforementioned meeting in July 2012, the NPC stated that the company does not intend to invest in expensive pollution control equipment, which would negatively impact the economic return of the project. If hydrogen sulfur pollution exceeds limits in Reykjahlíd, the company says that it will respond to that in a proper manner, but all plans on executing such responses remain to be seen.

Effects of airborne pollutants on the Mývatn-Laxá ecosystem are poorly understood and remain an unknown risk factor to the integrity of the system.

Conclusion

This paper reports on serious concern about the possible negative impacts on the Mývatn-Laxá ecosystem and on local people due to the proposed 90MW geothermal power plant in Bjarnarflag. It raises a few questions that need to be answered by the Icelandic Power Company:

1) How secure is the underground pumping of waste water from the Bjarnarflag plant, and what plans does the NPC have to respond to possible failures of pumping or storing it?
2) How much cooling of the natural groundwater is expected to occur, and which plans are in place to remedy such cooling?
3) How does the NPC intend to respond to the imminent exceeding of health limits due to hydrogen sulfur pollution in the town of Reykjahlíd?

It should also be noted that the environmental impact assessment for the plant needs to be updated but it was published almost 10 years ago. Finally, the combined effects of both the Krafla and Bjarnarflag projects on the ecological character of the Mývatn-Laxá ecosystem need to be examined.

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